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OCEAN CURRENT EFFECTS ON MARINE SEISMIC SYSTEMS AND DEPLOYMENTS--ETC(U)
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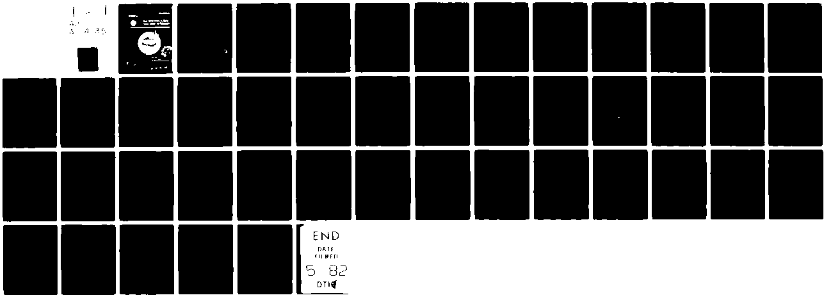

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ABSTRACT

Upper level and near bottom current measurements were made near DSDP Hole 395A (22°45'N, 46°10'W) in March-April 1981 in support of the at-sea test of the Marine Seismic System Project. Four upper ocean current profiles were made during initial deployment of the borehole seismometer. Readings were noticeably contaminated by ship motion, but clearly indicated a variable yet generally slow current regime which posed minimal threat of cable entanglement. Current measurements made 5 m off bottom during seismometer testing showed marked spectral peaks at semidiurnal and inertial frequencies. Mean speed of 4.4 cm/sec and maximum speed of 9 cm/sec were low but possibly of sufficient magnitude to cause contamination of concurrently deployed ocean bottom seismometer records with hydrodynamically generated noise. Other studies have confirmed noise contamination of OBS records by near bottom currents, with a possible 10 cm/sec threshold for its importance. While methods to detect and eliminate the noise might be developed, instrument testing and redesign to reduce sensitivity to contamination is probably wiser.

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ACKNOWLEDGEMENTS

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I. Introduction

Two types of physical oceanographic measurements were supplied by NORDA Code 331 in support of the March-April 1981 at-sea test of the Marine Seismic System (MSS) Project. Four profiles of ocean currents in the upper 1000 meters were taken from the USNS LYNCH with a Neil Brown Instrument Systems (NBIS) direct reading current meter (DRCM) prior to and during deployment of the borehole seismometer. Completed profiles were transmitted immediately to the CHALLENGER where the data were used to orient the ship so as to avoid entanglement of the seismometer cable with the drill string. In addition, two Sea Link System vector averaging current meters (VACM's) were deployed approximately five meters off the bottom to help estimate hydrodynamic noise contamination of the records of concurrently deployed ocean bottom seismometers (OBS's). Details of the VACM deployment are given in Table 1; positions of the VACM's, the operational OBS, and DSDP Hole 395A are shown in Figure 1. Positions of DRCM casts were within about 0.5 n mi of Hole 395A. This report summarizes the results of the DRCM casts and the two VACM deployments, comments on the DRCM results, and discusses the contamination of seismometer signals by hydrodynamic noise.

II. Background

II-A. Upper Level Current Profiles

The possibility of entanglement of the borehole seismometer cable with the drill string was a major concern during deployment of the package. Upper level current measurements were needed during the seismometer deployment because it was felt that were the currents known, the CHALLENGER could be oriented so as to keep the cable downstream of the drill string. Along with several other measures, such positioning should substantially reduce the risk of entanglement. Equipment suitable for making accurate real time current measurements deeper than a few hundred meters was (and is) severely limited, particularly within the budgetary restrictions of the project. The NBIS direct reading current meter selected (underwater unit model DRCM-1, deck unit CMDT-1) was a new, readily available, but relatively untested meter using, however, previously developed and proven technology.

II-B. <u>Hydrodynamically Generated Noise</u>

Some unpublished results have shown near bottom currents can produce noise contamination in OBS records (Sutton, et al., 1981, Duennebier, et al., 1981). One aspect of the Lopez Island OBS Intercomparison Experiment (Sutton, et al., 1981, and other papers in that issue) was to examine sensitivity of different OBS systems to contamination from hydrodynamically generated noise. Results were inconclusive, but current speeds were low, a maximum of 6 cm/sec. Mean currents near DSDP Hole 395A were anticipated to be low (Wilcox, 1978), but there was no direct knowledge from the site. Since hydrodynamically induced noise is generally recognized as a possible problem with OBS's, it was felt that a knowledge of currents near the site could be valuable in identifying the sources of anomalous signals should they show up in the seismic records of the OBS's or borehole seismometer.

Currents can generate noise in seismic records in three ways. The first occurs when the fluid motion is highly turbulent. The drag and lift forces exerted on an instrument by the fluctuating flow may cause actual small motions or vibrations of the object which are recorded as noise. The second is by current generated noise being transmitted through the bottom and being picked up by the instrument. The noise may occur when random pressure fluctuations of the turbulent boundary layer actually disturb the bottom sediments, or nearby equipment may be disturbed by the turbulent flow with the motion being transmitted through the bottom. Under the low current speeds expected near Hole 395A, these sources of noise are unlikely to be as important as the third mechanism, the shedding of vortices from objects located in the flow.

The character of fluid flow past an object is largely determined by the Reynolds number, Re, defined as

$$Re = \frac{U \cdot d}{\nu}$$

where U is a characteristic speed of the flow, d a characteristic dimension of the object, and ν the kinematic viscosity. At low Re the fluid flow closely follows the contours of the body, but above a critical Re the boundary layer separates from the body and forms a turbulent wake. Up to a certain maximum Re the separation for some body shapes occurs nearly periodically in the form of shedding of pairs of alternate sense vortices. Separation and wake formation causes a reduced pressure gradient in the lee of the object, particularly on the side from which a vortex is shed. The shedding of opposite-sense vortices in a wake produces nearly periodic forces on the body at the Strouhal frequency f_s. This is the source of aeolian tones caused by wind over wires under tension and the "strumming" of hydrographic cables during CTD casts. For cylindrical bodies normal to the flow and for $4 \times 10^1 < Re < 4 \times 10^5$ this frequency is given by

$$f_s = \frac{U \cdot S}{d}$$

where S is the Strouhal number (Batchelor, 1967). (There is some dependence on geometry and turbulence level of the free stream, but this gives f_s well within an order of magnitude.) For Re > 200, the Strouhal number may be taken for our purposes as a constant .2 (Gerrard, 1978).

The sensitive range of many contemporary seismometers includes the range of Strouhal frequencies due to currents that one would expect to encounter in the deep ocean. For example, the University of Texas OBS's used in the recent MSS cruise have a range of about .01 - 30 Hz (R. Jacobsen, personal communication). In his summary of deep ocean current speeds, Wilcox (1978) found a mean deep current speed in the Eastern Atlantic of about 5 cm/s. For a 1" cable this translates into a Strouhal frequency of about .4 Hz.

It is clear, then, that there is potential for the contamination of seismometer readings by noise from turbulent eddy shedding. Whether this contamination actually occurs or not remains to be seen.

III. Measurements

The NBIS direct reading current meter selected for the upper level current profiles had a specified speed accuracy of $\pm$ 1 cm/s or 5% (whichever greater). Direction accuracy was $\pm$ 5° for speeds greater than 10 cm/s. Pressure was accurate to $\pm$ 1. decibar and precise to $\pm$ .05 decibar (A.W. Green, personal communication). One minute vector averages of speed and direction were recorded and pressure was periodically checked to provide depth values.

Near bottom measurements were taken with Sea Link vector averaging current meters (model 610), which recorded average speed, direction and temperature every 15/16 minutes. Speed was accurate to $\pm$ 1 cm/s or better, and the threshold of the Savonious rotor was 3 cm/sec or lower. Direction was accurate to $\pm$ 3°. The installed thermistors were accurate to $\pm$ .1°C and precise to $\pm$ .01°C. The manufacturer's manual (AMF, 1976) gives further details on instrument construction, and Woodward and Appel (1973) and McCullough (1975) describe determination of accuracies. The mechanical rotor of the VACM tends to stall at low current speeds, so the VACM was not the optimal instrument for the low currents anticipated. However, it was the only meter type available with a pressure casing suitable for the 4500 m depth. In spite of current speeds near rotor stall speed, the two instruments performed adequately.

IV. Presentation of Data

IV-A. Upper Level Current Profiles

Velocity profiles taken with the DRCM during the seismometer deployment are given in the Appendix. Near the end of the fourth cast occasional erratic behavior occurred and the equipment failed at the beginning of the fifth. Attempts to diagnose the problem were unsuccessful except to indicate the problem probably lay in the underwater unit rather than the deck unit. The equipment was later returned to NBIS where they found a manufacturing error had caused a seal failure and seawater leakage sometime during the profiling, presumably towards the end of cast 4 or the beginning of cast 5.

The indeterminacy of the failure time precludes a strict evaluation of the quality of the profile data. There are considerable differences between profiles. In particular, the first cast showed substantially higher current speeds than succeeding casts. However, fixes taken by ship's personnel on the CHALLENGER every 20 minutes during the profiling indicated a drift of 1/3-1/2 kt to the northeast during the first cast, a larger drift than at any other time during the profiling. (A considerable wire angle was also noted at this time.) Perhaps the higher observed values for this profile were indeed correct, due to wind or surface current induced ship motion or to a transient, highly energetic current regime.

There is no question that ship motion affected the DRCM readings at other times. During periods of swell when the LYNCH rolled substantially, the pressure values commonly indicated vertical excursions of more than $\pm$ 5 dbar. When the wire from the hydrographic winch executed a circular motion at the surface, instantaneous direction measurements often changed rapidly and monotonically.

It seems reasonable to conclude that the DRCM and deck unit performed adequately until the end of cast 4 or the beginning of cast 5. However, the measurements were contaminated by ship motion. It was known from the beginning that ship motion would affect the DRCM data, but neither time nor resources were available to compensate for the motion. The purpose of the DRCM was to furnish approximate ($\pm$ 20 cm/s) upper bounds for the currents, and it appeared to satisfy this requirement until obvious failure.

IV-B. Near Bottom Data Editing and Time Series

The near bottom velocity data were first plotted as time series to examine each record for anomalous data, and records were discarded for those times the meters were not on the bottom. Meter 289 performed well. Occasional isolated spikes - usually from erroneous direction values - were replaced with linearly interpolated values. The final series for meter 289 is given in Fig. 2. Meter 300 performed satisfactorily in view of the very low current speeds encountered, but had a higher stalling threshold than meter 289, as seen in Fig. 3. Superposition of Figures 2 and 3 show, however, that when meter 300 was not stalled the measured current speeds and directions for both were quite similar. Current speeds tended to be low (below 10 cm/s) with minor high frequency fluctuations superimposed upon a very distinct periodicity of about 2 cpd. Direction changed continuously with a period somewhat greater than 1 day. These motions were later explained when spectral analysis confirmed considerable energy at the inertial-diurnal (given our frequency resolution, they are close, 31 hr period versus 23.9 hr period) and semidiurnal frequencies.

Temperature time series from both meters were examined for anomalous data and records discarded from those times the meters were not in position. No editing was required. The temperature was nearly constant for both series (Figures 4 and 5). The VACM temperature sensor is located on top of the meter case and the approximately 12 hour duration transient at the beginning of each record can be attributed to the effects of convection of water warmed by the meter case before it reached ambient temperature. Once the cases reached ambient temperature, measured temperatures held very constant at about 2.4°C as would be expected for the anticipated North Atlantic Bottom Water (NAVOCEANO, 1966, and Fleischer, 1980).

IV-C. Near-Bottom Current Statistics

Figures 6 and 7 show speed, direction, and cumulative speed distribution histograms. Basic statistics are given in Tables 2 and 3. Speeds when the rotor is stalled are recorded as approximately 2 cm/s, so all speeds between 0.-2. cm/s are tabulated in Figures 6 and 7 and Tables 2 and 3 as occurring in the 2.-2.5 cm/s range. Only meter 289 provided a reliable estimate of average speed since meter 300 tended to stall at low speeds. Average scalar speed for meter 289 was 4.4 cm/s and vector mean speed was 2.1 cm/s in a direction of 012°T. Maximum speed for meters 289 and 300 were 8.9 and 7.9 cm/s, respectively. The prevalence of low speeds on either side of around 220°T and the relative frequency of high speeds around 0° in Figures 6 and 7 reflect the presence of the roughly northward mean flow. Progressive vector diagrams in Figures 8 and 9 further confirm the conclusion that the mean flow was northward with direction reversal on an approximately daily basis.

IV-D. Near-Bottom Current Spectra

The u-v (east-north) and clockwise-counterclockwise velocity spectra are presented in Figures 10 to 15. Annotations indicate the periods of a number of conspicuous peaks.

In spite of the short 3.3 day record length, peaks near diurnal and semi-diurnal periods are quite distinct. The inertial period of 31 hours is rather close to the K_1 tidal period (23.93 hours), but the near-diurnal peak is probably due largely to inertial currents, for two reasons. First, near the diurnal peak the clockwise rotary spectral components are much larger than the counterclockwise. Second, the u and v spectra at that frequency are of nearly equal magnitude. While these criteria are not sufficient to unequivocally identify inertial oscillations, they are necessary characteristics that northern hemisphere inertial oscillations must possess. If the motions are indeed primarily inertial oscillations, they may be episodic, their occurrence in a given record depending upon the presence of a forcing phenomenon. On the other hand, the K_1 tidal component at 23.93 hours may regularly excite the inertial oscillations at 31 hours, the amplitude of the oscillations depending on the amplitude of the K_1 tide. Under these conditions the near-diurnal oscillations would be permanent features of the current structure.

A second prominent spectral peak occurs near the semidiurnal tidal period of 12.42 hours and is probably the M_2 tide. Tidal signals in the open ocean are frequently not this energetic relative to the rest of the spectrum, and this peak may reflect the influence of the nearby topography as well as the absence of other forcing phenomena. The other spectral peaks are much smaller in amplitude and any connection with other obvious or important physical processes is not apparent.

Temperature spectra were calculated but are not presented because they confirmed what is apparent in Figures 4 and 5: there is virtually no variation in temperature about the mean of 2.4°C, and in particular there is no evidence of any diurnal or semidiurnal periodicity.

V. Summary and Conclusions

Real-time current profiles were taken near DSDP Hole 395A on 26-27 March 1981 from the USNS LYNCH with an NBIS direct reading current meter. The profiling was done during the initial deployment of the Marine Seismic System Project's borehole seismometer from the R/V GLOMAR CHALLENGER. Readings indicated a variable but generally slow current regime. Sea state conditions 0 or 1 prevailed during the profiling. Nevertheless, significant contamination of the records by ship motion was apparent, and deployment from the CHALLENGER would have been preferable. Unless techniques are applied to decouple the profiler from the ship's motion, it appears inadvisable to deploy the DRCM from a platform as unstable as an AGOR above sea state 1 or 2. For higher sea state, satisfactory results could be expected only when the current regime is sufficiently high that ship motion induced noise does not mask the background current measurements, although the accuracy of the measurements would still be reduced. In spite of the ship motion contamination, however, observed current speeds in the upper 1000 m were generally low and posed minimal threat of cable entanglement.

Sea Link vector averaging current meters deployed near the bottom in 4483 m of water for 3-1/2 days in March - April 1981 in support of the MSS Project performed well under conditions of very low current speeds. Average (scalar) speed was 4.4 cm/sec and maximum speed was under 9 cm/sec. The mean direction of flow was slightly east of north, with a steady clockwise rotating component of period somewhat greater than one day superimposed on the mean flow. The rotating component can be attributed to inertial oscillations which may be forced by the diurnal tide. The semidiurnal tide was also apparent and at a sufficiently energetic level that topographic forcing may be implicated. Temperature was constant at 2.4°C.

The observed currents were of sufficient magnitude potentially to excite instrument "strumming" due to vortex shedding at frequencies within the sensitive range of the concurrently deployed ocean bottom seismometers (.01 - 30 Hz: see Table 4). Figure 16 shows estimated vortex shedding frequencies for four sizes of cylinders for currents in the range of the current meter observations. The complicated geometries of the OBS's make it difficult to isolate any particular components that might be likely to contribute strumming noise except perhaps for the radio beacon antennas. Assuming an antenna rod thickness of 1/8", the strumming frequency would be 6 Hz at 9 cm/s and 3 Hz at 4.4 cm/s. If this corresponded to a resonant frequency of the rod or of the attached flag, strumming amplitude could be substantial. Duennebier, et al. (1981) did report noise signals in OBS recordings that could be attributed to vortex shedding from various antenna configurations.

As reported by Duennebier, et al. (1981), Kasahara et al. (in press) found 10 cm/s to be a threshold for noise contamination by vortex shedding. Maximum currents in this study were 9 cm/s, suggesting contamination of these OBS records is likely to be small and intermittent. But Figures 2 and 3 illustrate the fact that deep water, near bottom current regimes are characterized by considerable variability in speed and direction. Internal tides, inertial oscillations, and other phenomena make it a mistake to assume that the operating environment of a deep water OBS will be characterized by steady, slow currents. The variable and possibly episodic nature of these current features can make it difficult to detect and remove noise contamination. The development of methods of evaluating noise contamination to the seismometer records is recommended, as well as the testing of OBS's for sensitivity to current generated noise and their redesign to eliminate as much as possible.

One approach to evaluating noise contributions from vortex shedding would be to compute for each external OBS component a time series of shedding frequency from the observed current time series. Coherence between OBS signal level and the shedding frequency time series could give an indication of the current's influence. Such a technique could also be applied to the borehole seismometer and related hardware if it were felt that the instrument might be influenced by vortex shedding off components on the bottom.

The better approach, particularly in view of the complicated geometry of OBS systems and difficulty and expense of making current measurements, is noise sensitivity evaluation and instrument redesign. To evaluate the response at different fluid speeds the instrument could be placed in a tank or wind tunnel, and the equipment either moved through the fluid or the fluid moved past it and the pure noise signal recorded. A very important point is that the fluid could be air rather than water if proper Reynolds' scaling were observed.

This study as well as others show there is potential for OBS observational data to be contaminated by hydrodynamically generated noise. Up to now investigation of the importance of the problem has been neglected, but methods of evaluating the magnitude of the problem for various OBS designs and of solving it, should it prove significant, should be addressed in the future.

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Table 1. Details of MSS Current Meter Moorings Near

DSDP Hole 395A (22°45.35'N, 46°04.90'W)

Cruise Number: USNS LYNCH 070581

		Mooring 000901	Mooring 001001
Position:	Latitude	22°46.35'N	22°46.10'N
	Longitude	46°04.59'W	46°05.49'W
Dates:[1]	From	1526Z 28 March 1981	1814Z 28 March 1981
	To	0837Z 01 April 1981	0837Z 01 April 1981
Water Depth (m)		4483	4483
Meter Depth (m)		4478	4478
Sampling Rate (sec)		56	56
Meter number		289	300
Performance		Very good	Satisfactory

[1]Dates are conservatively estimated times moorings were in position.

CRUISE: 070581 MOORING:000901
METER: 289 START: 1526Z 28 MAR 1981 LATITUDE: 22.46.350
DEPTH: 4478 END: 0837Z 01 APR 1981 LONGITUDE: -46. 4.589

SPEED	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0		
0- 10						1		9	21	13	35	39	65	58	64	32	14	6				357	6.3
10- 20							4	58	32	41	33	20	50	50	13	4	15	14				334	5.9
20- 30					1	2	15	11	17	10	3	17	50	29	12	18	4					189	3.3
30- 40					1	2	25	8	1	5	24	33	21	14	7	2						143	2.5
40- 50					51	12	50	6	20	2	17	32	25	1								216	3.8
50- 60						4	26	24	17	30	52	51	23									227	4.0
60- 70					6	2	65	42	10	36	22	18	3									204	3.6
70- 80					6	24	31	15	11	37	21	13	3									161	2.8
80- 90					15	20	83	26	8	16	19	15										202	3.5
90-100					21	9	52	45	24	38	41	15	2									247	4.3
100-110					20	25	73	94	29	20	4											265	4.6
110-120					57	13	42	63	21	6												202	3.5
120-130							12	18	5													35	.6
130-140							19	20	4	2												45	.8
140-150							18	2	13	15	13											61	1.1
150-160						16	12	20	16	14	2											80	1.4
160-170						10	12	13	7													42	.7
170-180						4	12	1														17	.3
180-190						7	14															21	.4
190-200					12	4	8	1														25	.4
200-210					128	15	5	5														153	2.7
210-220				1	150	4	5															160	2.8
220-230					104	10	9															123	2.2
230-240				1	41	22	7															71	1.2
240-250					26	19	13															58	1.0
250-260					18	25	11															54	.9
260-270					39	38	15	1														93	1.6
270-280					2	19	28	7	2													58	1.0
280-290					19	30	43	16	4	3												115	2.0
290-300					23	45	46	11	7	4	7	5	23	14								185	3.2
300-310					19	33	54	49	51	20	5	15	41	20								307	5.4
310-320					17	22	29	22	28	20	35	18	8									199	3.5
320-330					1	3	19	69	35	15	45	44	30									261	4.6
330-340					2	10	29	39	42	27	40	36	25	3								253	4.4
340-350						3	7	12	8	20	88	63	11	19	34	2						267	4.7
350-360						2	4	14	8	10	31	20	2	28	125	35						279	4.9
SUM	0	0	0	2	779	455	857	721	441	404	537	454	382	236	255	93	33	20	0	0	0	5709	
PER CT.	.0	.0	.0	.0	13.6	8.0	15.7	12.6	7.7	7.1	9.4	8.0	6.7	4.1	4.5	1.6	.6	.4	.0	.0	.0		

NUMBER OF ZERO SPEEDS	0		PERCENTAGE ZERO SPEEDS	.0			
NUMBER OF OBS.	5709		NUMBER MISSING OBS.	0			
AVERAGE SCALAR SPEED	4.35	CM/SEC	MAXIMUM/MINIMUM U	6.05	CM/SEC	-6.06	CM/SEC
STANDARD DEVIATION	1.58	CM/SEC	MAXIMUM/MINIMUM V	8.81	CM/SEC	-4.51	CM/SEC
VECTOR MEAN SPEED	2.14	CM/SEC	MAXIMUM SPEED	8.93	CM/SEC		
VECTOR MEAN DIRECTION	11.64	DEGREES	DIRECTION OF MAX SPD	9.76	DEGREES		

Table 2. Meter 289 basic current statistics.

CRUISE : 070581 | METER: 300 | DEPTH: 4478

MOORING:001001 | START: 18142 28 MAR 1981 | END: 08372 01 APR 1981

LATITUDE: 22 46.102 | LONGITUDE: -46. 5.493

0- 10					168	3	5	9	35	35	13	5	2	8								283	5.1
10- 20					244		7	32	49	27												359	6.5
20- 30					129		7	33	65	15												253	4.6
30- 40					31	3	22	49	32	19	2											158	2.9
40- 50					47	3	19	8	6		7	6	2									98	1.8
50- 60					11	6	27	30	1	6	4	5										90	1.6
60- 70					49	9	24		14	6	2											104	1.9
70- 80					24	2	13	15	7	5	5	2										73	1.3
80- 90					26	3	26	31	6	13	27	7										139	2.5
90-100					31		15	25	22	15	6											114	2.1
100-110					55		3	24	10	3												95	1.7
110-120					12	1	7	13	10	1												44	.8
120-130					76	15	15	5	5													116	2.1
130-140					155	11	23	23	14	1												227	4.1
140-150					60	2	14	7	2	6	1											92	1.7
150-160					160	2	24	32	10													228	4.1
160-170					105	5	33	35	12													190	3.4
170-180					97	12	43	33														185	3.3
180-190					66	12	28	5														111	2.0
190-200					21	9	17															47	.9
200-210					14	8	6	2														30	.5
210-220					21	5	5	8														39	.7
220-230					48	4	2	10														64	1.2
230-240					65	1	5	22	3													96	1.7
240-250					86		12	24	1													123	2.2
250-260					91	2	4	8	1													106	1.9
260-270					51		5	20	6													82	1.5
270-280					137	11	8	40	14													210	3.8
280-290					173	7	30	47	5													262	4.7
290-300					176	41	31	12	2													262	4.7
300-310					94	20	4	5														123	2.2
310-320					73	2		8	11	4	2											100	1.8
320-330					40	2		13	45	63	55	1										219	4.0
330-340					16			4	34	104	40	2	2									202	3.7
340-350					81		3	17	16	31	22	12	20	9	22	1						234	4.2
350-360					135	11	4	16	33	21	38	19	3	14	51	26						371	6.7
SPEED	.0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0		
SUM	0	0	0	0	2868	212	451	665	471	379	224	59	29	31	73	27	0	0	0	0	0	5529	
PER CT.	.0	.0	.0	.0	51.9	3.8	6.9	12.0	8.5	6.9	4.1	1.1	.5	.6	1.3	.5	.0	.0	.0	.0	.0		

NUMBER OF ZERO SPEEDS	0		PERCENTAGE ZERO SPEEDS	.0		
NUMBER OF OBS.	5529		NUMBER MISSING OBS.	0		
AVERAGE SCALAR SPEED	3.09	CM/SEC	MAXIMUM/MINIMUM U	5.68	CM/SEC	-4.29 CM/SEC
STANDARD DEVIATION	1.27	CM/SEC	MAXIMUM/MINIMUM V	7.86	CM/SEC	-4.19 CM/SEC
VECTOR MEAN SPEED	.93	CM/SEC	MAXIMUM SPEED	7.86	CM/SEC	
VECTOR MEAN DIRECTION	357.51	DEGREES	DIRECTION OF MAX SPD	357.95	DEGREES	

Table 3. Meter 300 basic current statistics.

Table 4. Diameters of Cylindrical Bodies that would Oscillate at the Extrema of the OBS Frequency Range under Mean and Maximum Current Conditions Observed

Frequency	Mean Speed= 4.4 cm/sec	Max. Speed= 9 cm/sec
.01 Hz	.011 cm	.0056 cm
30 Hz	34.1 cm	16.67 cm

Applicable formula:

$$d = \frac{f_s}{.2 \cdot U}$$

where: d = object diameter
f_s = frequency
U = current speed

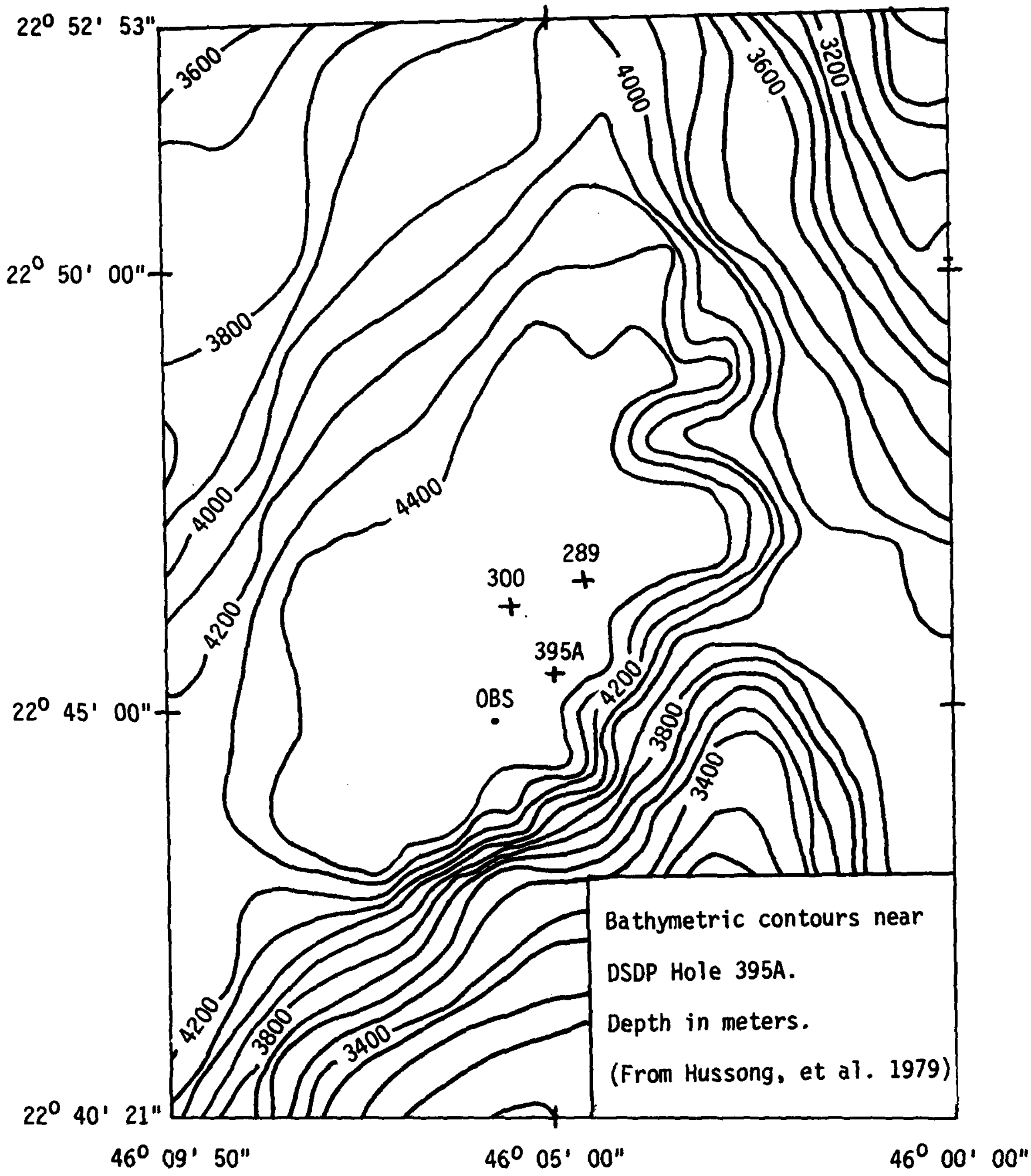
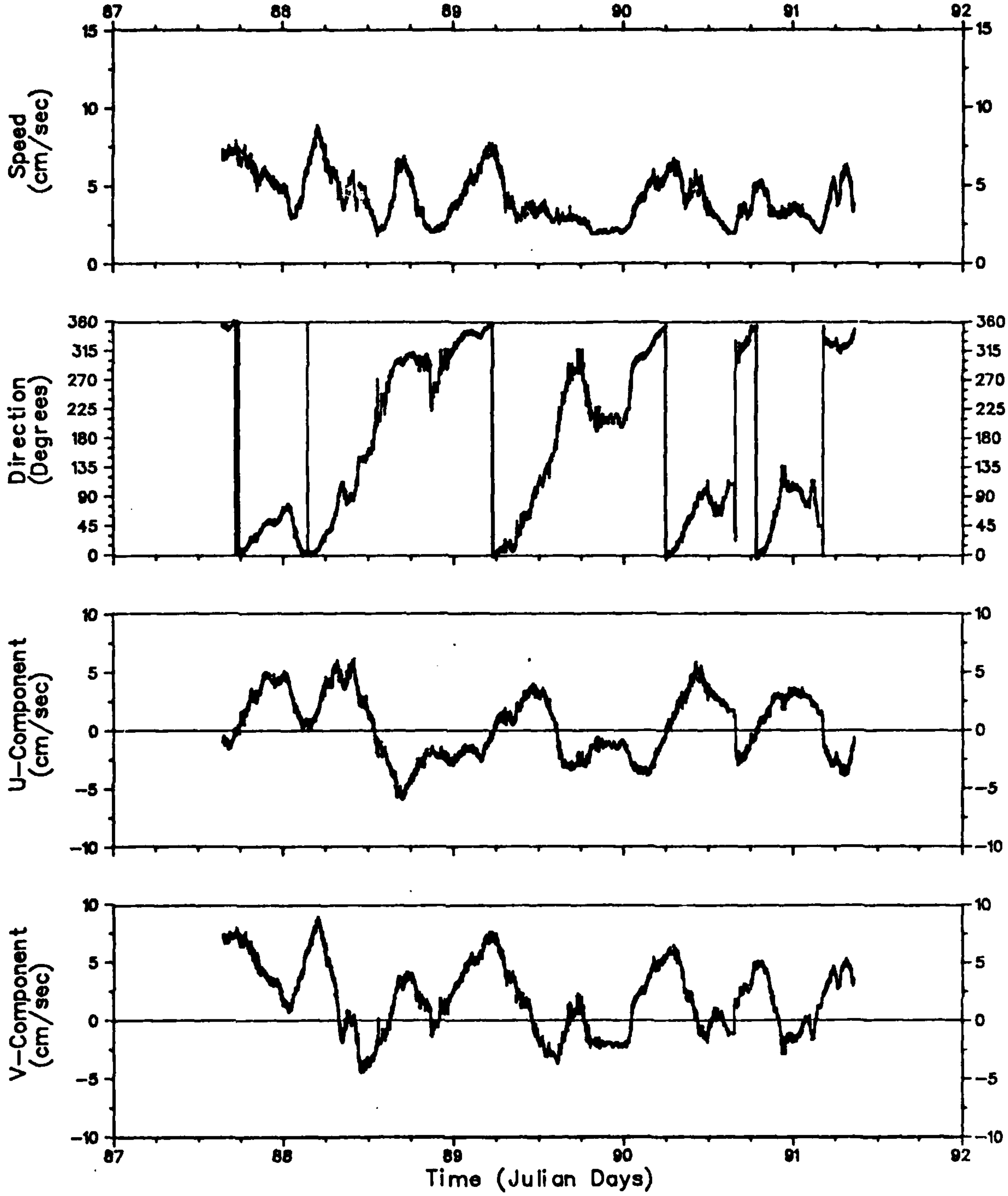


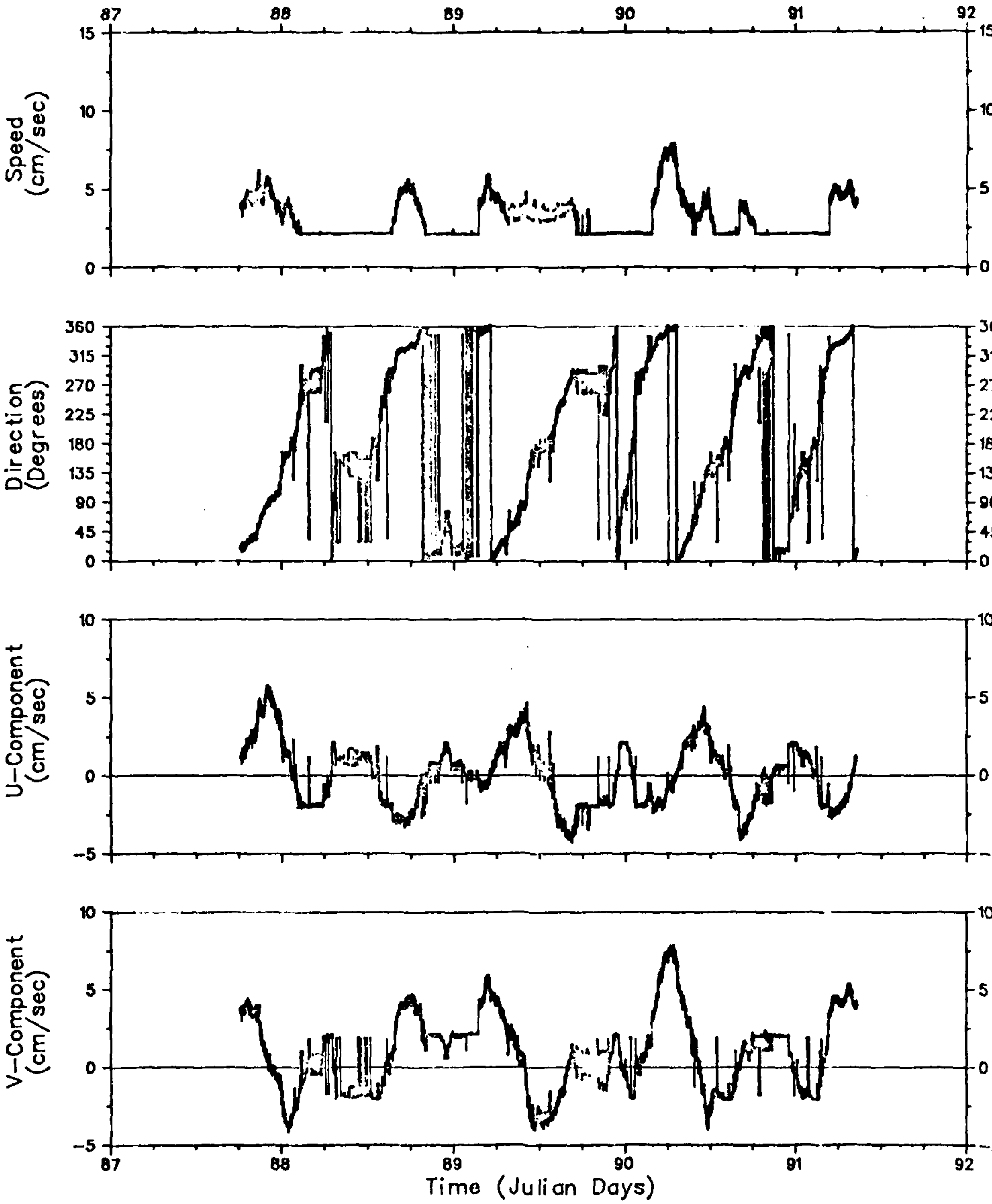
Figure 1. Locations of current meters 289 and 300, of Hole 395A, and of the operational OBS during March-April 1981 MSS at-sea test.



Cruise: 070581
Meter : 289
Latitude : 22.46.35
Longitude : –46. 4.58

Mooring: 000901
Depth : 4478
Start : 1526Z 28 MAR 1981
End : 0837Z 01 APR 1981

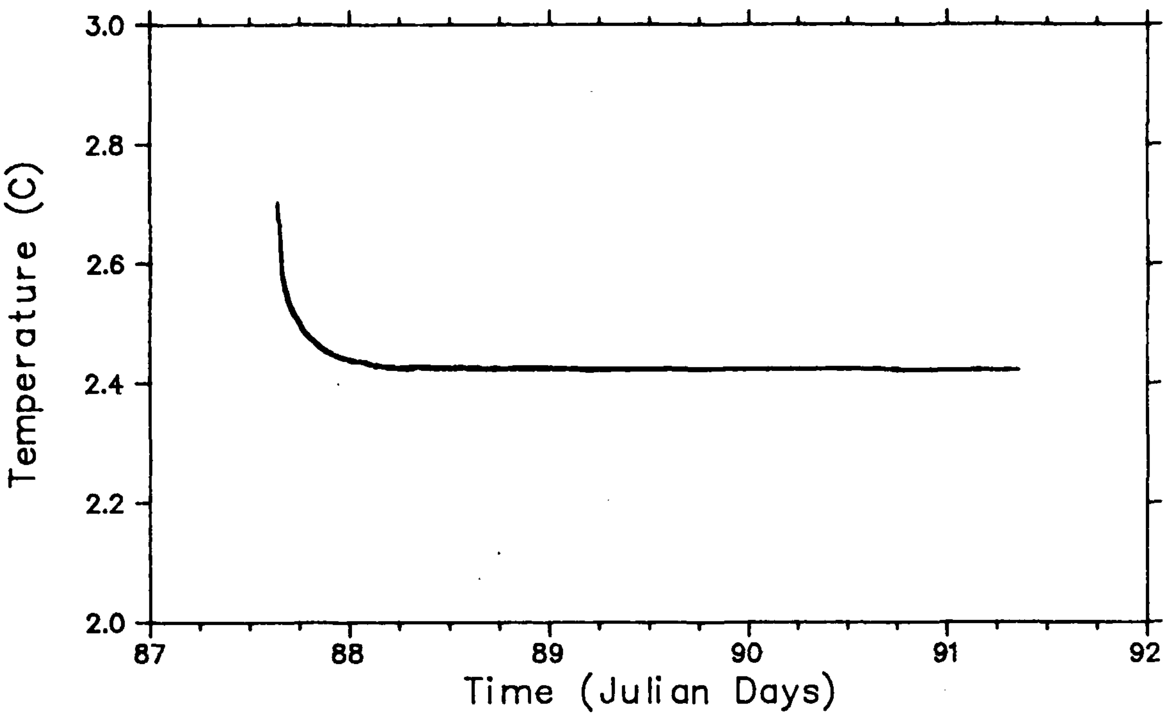
Figure 2. Meter 289 current time series



Cruise: 070581
Meter : 300
Latitude : 22.46.10
Longitude : -46. 5.49

Mooring: 001001
Depth : 4478
Start : 1814Z 28 MAR 1981
End : 0837Z 01 APR 1981

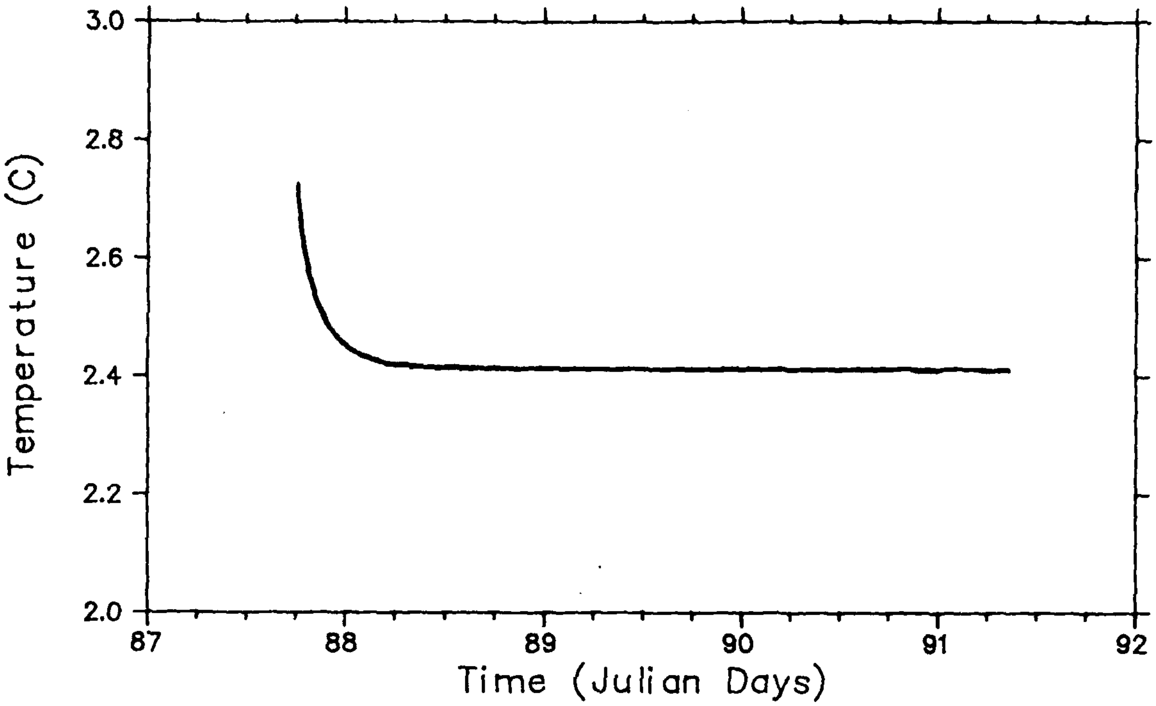
Figure 3. Meter 300 current time series



Cruise: 070581
Meter : 289
Latitude : 22.46.35
Longitude : -46. 4.58

Mooring: 000901
Depth : 4478
Start : 1526Z 28 MAR 1981
End : 0837Z 01 APR 1981

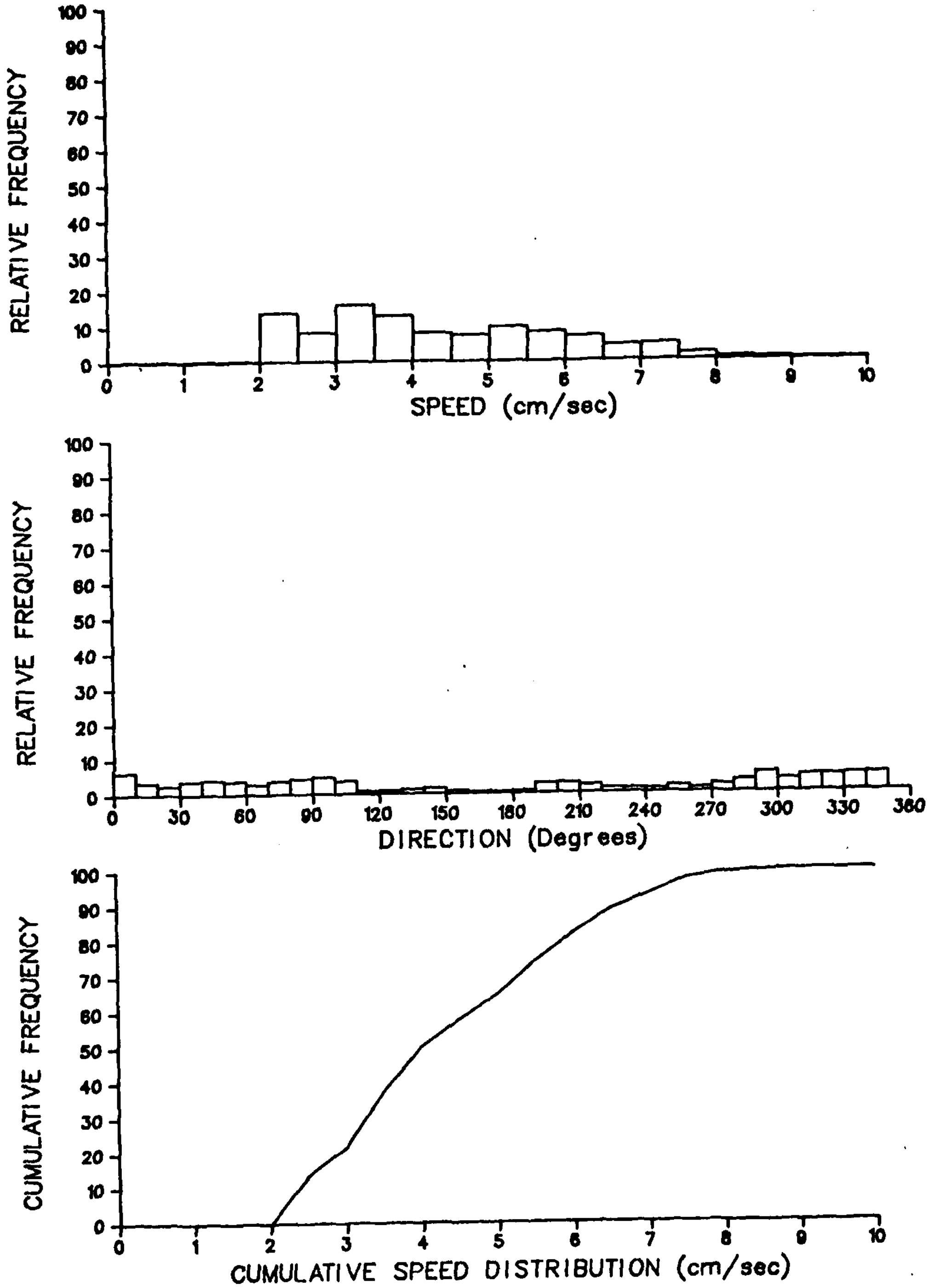
Figure 4. Meter 289 temperature time series



Cruise: 070581
Meter : 300
Latitude : 22.46.10
Longitude : -46. 5.49

Mooring: 001001
Depth : 4478
Start : 1814Z 28 MAR 1981
End : 0838Z 01 APR 1981

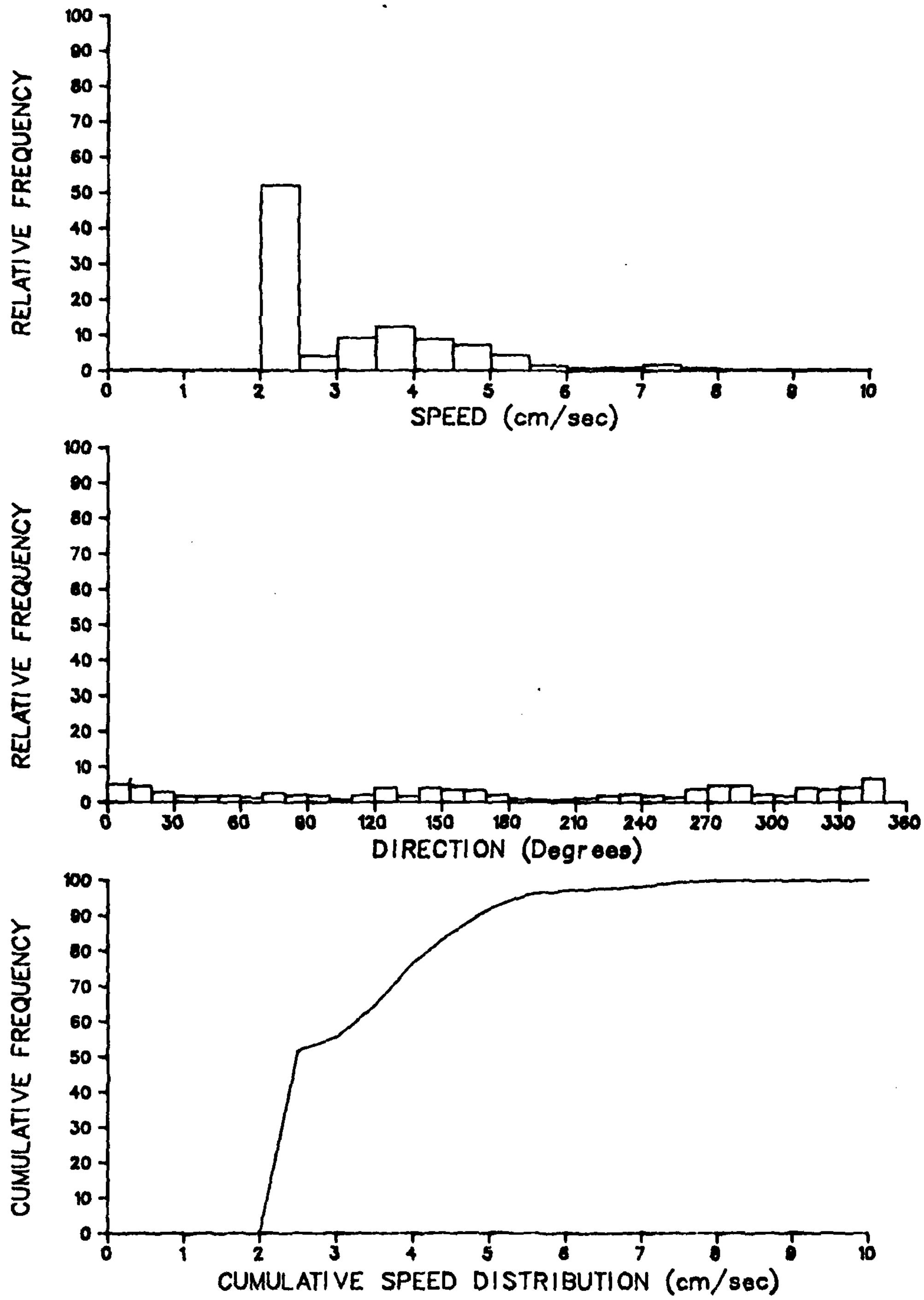
Figure 5. Meter 300 temperature time series



Cruise: 070581
Meter : 289
Latitude : 22.46.35
Longitude : -46. 4.58

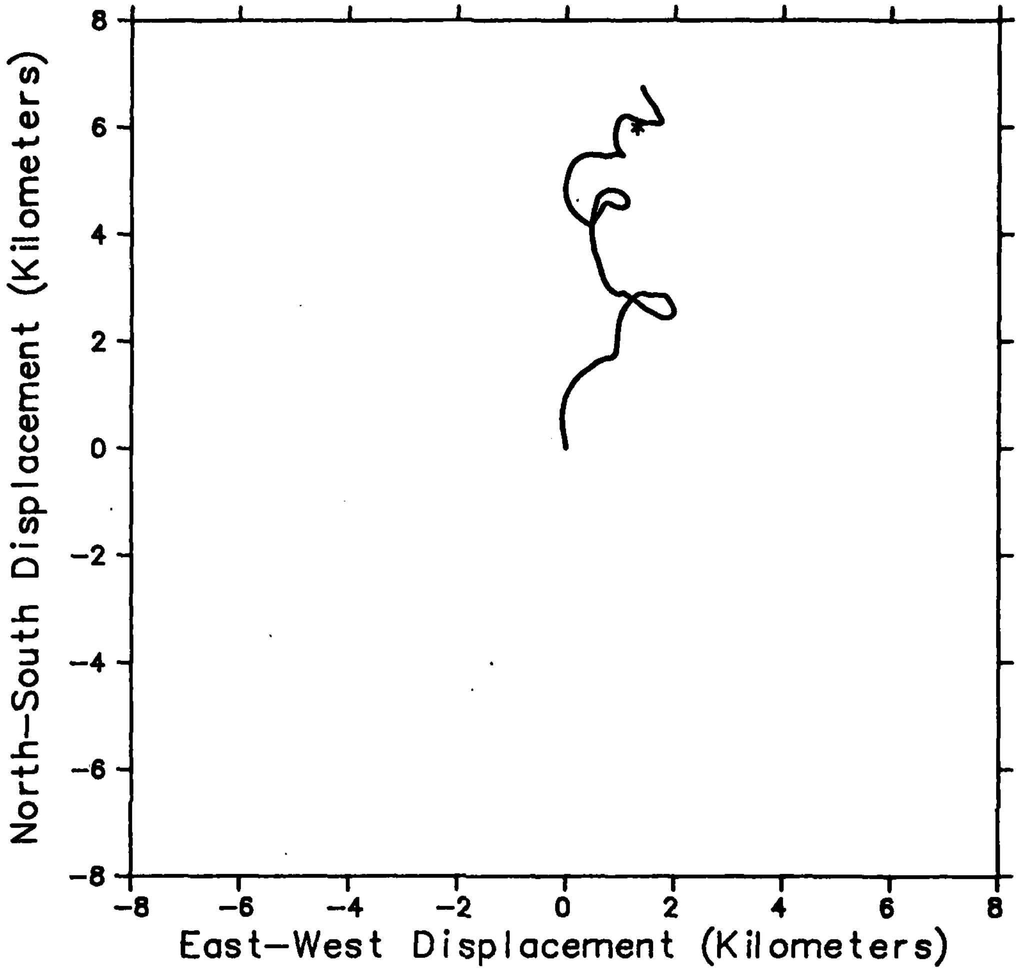
Mooring: 000901
Depth : 4478
Start : 1526Z 28 MAR 1981
End : 0837Z 01 APR 1981

Figure 6. Meter 289 current speed and direction histograms



Cruise:	070581	Mooring:	001001
Meter :	300	Depth :	4478
Latitude :	22.46.10	Start :	1814Z 28 MAR 1981
Longitude :	-46. 5.49	End :	0837Z 01 APR 1981

Figure 7. Meter 300 current speed and direction histograms

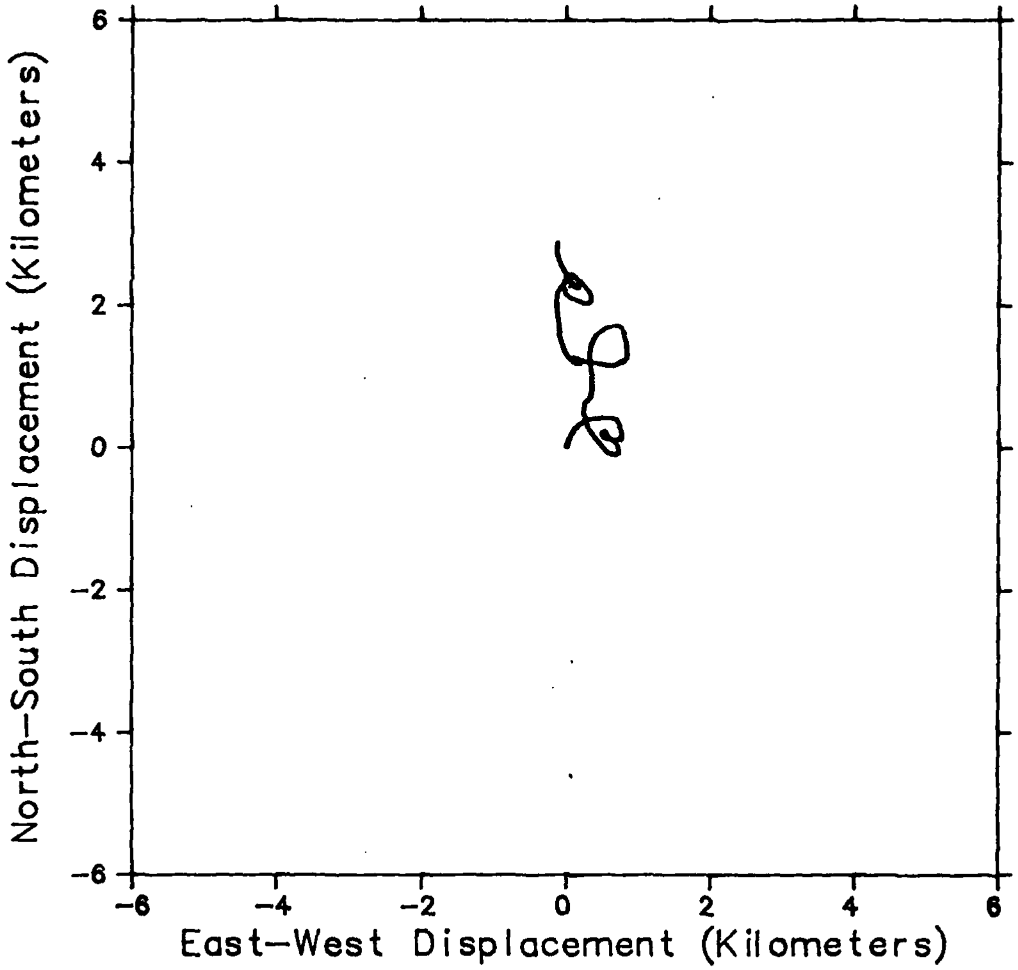


* Every 4.00 Days Starting At 0000 Julian Day 87

Cruise: 070581
Meter : 289
Latitude : 22.46.35
Longitude : -46. 4.58

Mooring: 000901
Depth : 4478
Start : 1526Z 28 MAR 1981
End : 0837Z 01 APR 1981

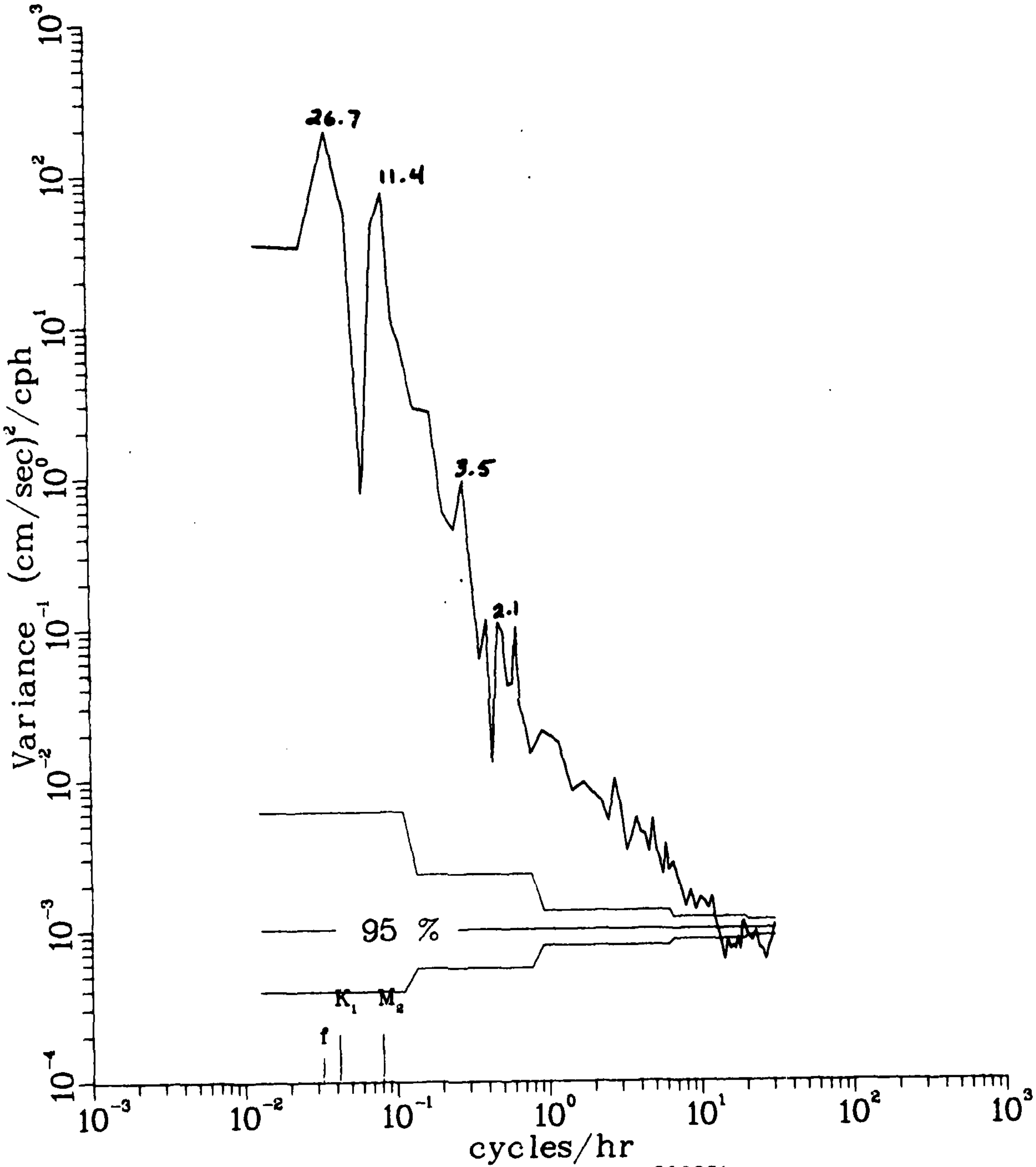
Figure 8. Meter 289 progressive vector diagram



* Every 4.00 Days Starting At 0000 Julian Day 87

Cruise:	070581	Mooring:	001001
Meter :	300	Depth :	4478
Latitude :	22.46.10	Start :	1814Z 28 MAR 1981
Longitude :	-46. 5.49	End :	0837Z 01 APR 1981

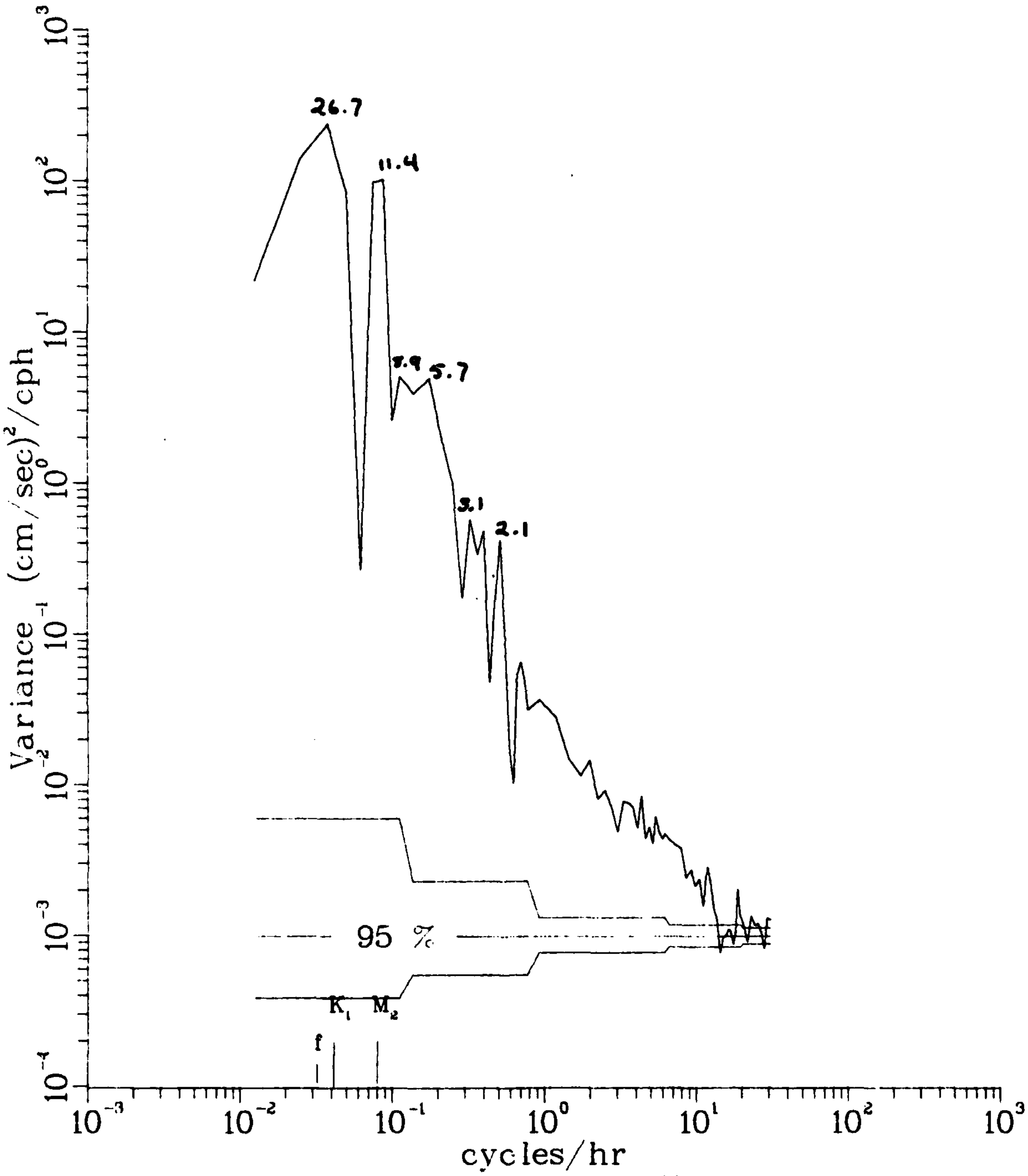
Figure 9. Meter 300 progressive vector diagram



Variable . U
File . 070581
Meter . 289
Lat. 22.46.350
Long. -46. 4.589

Array . 000901
Depth . 4478
Start . 28 MAR 1900
End . 31 MAR 1900

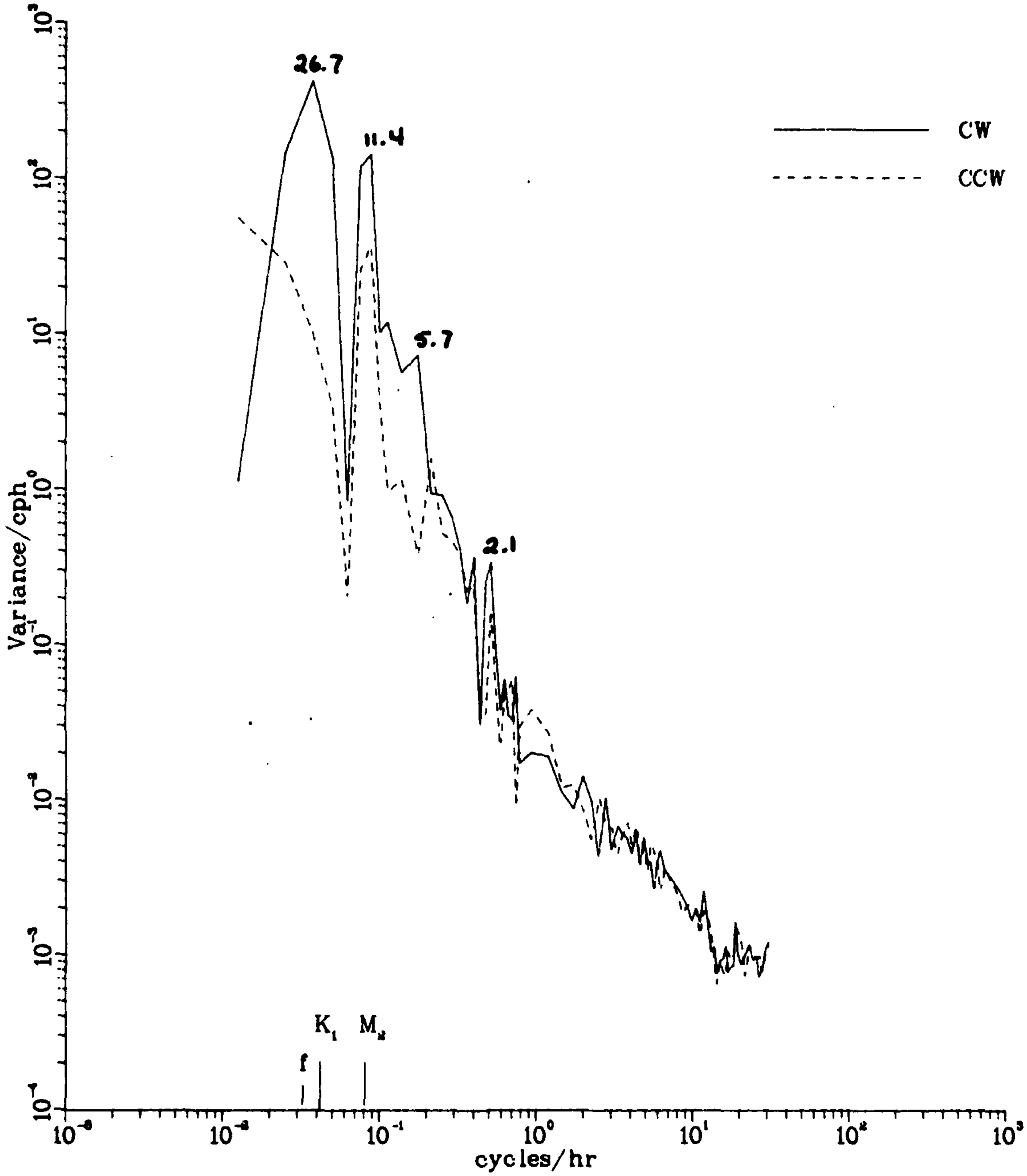
Figure 10. Meter 289 u(east) spectrum



Variable . V
File . 070581
Meter 289
Lat. 22.46.350
Long. -46. 4.589

Array . 000901
Depth . 4478
Start . 28 MAR 1900
End . 31 MAR 1900

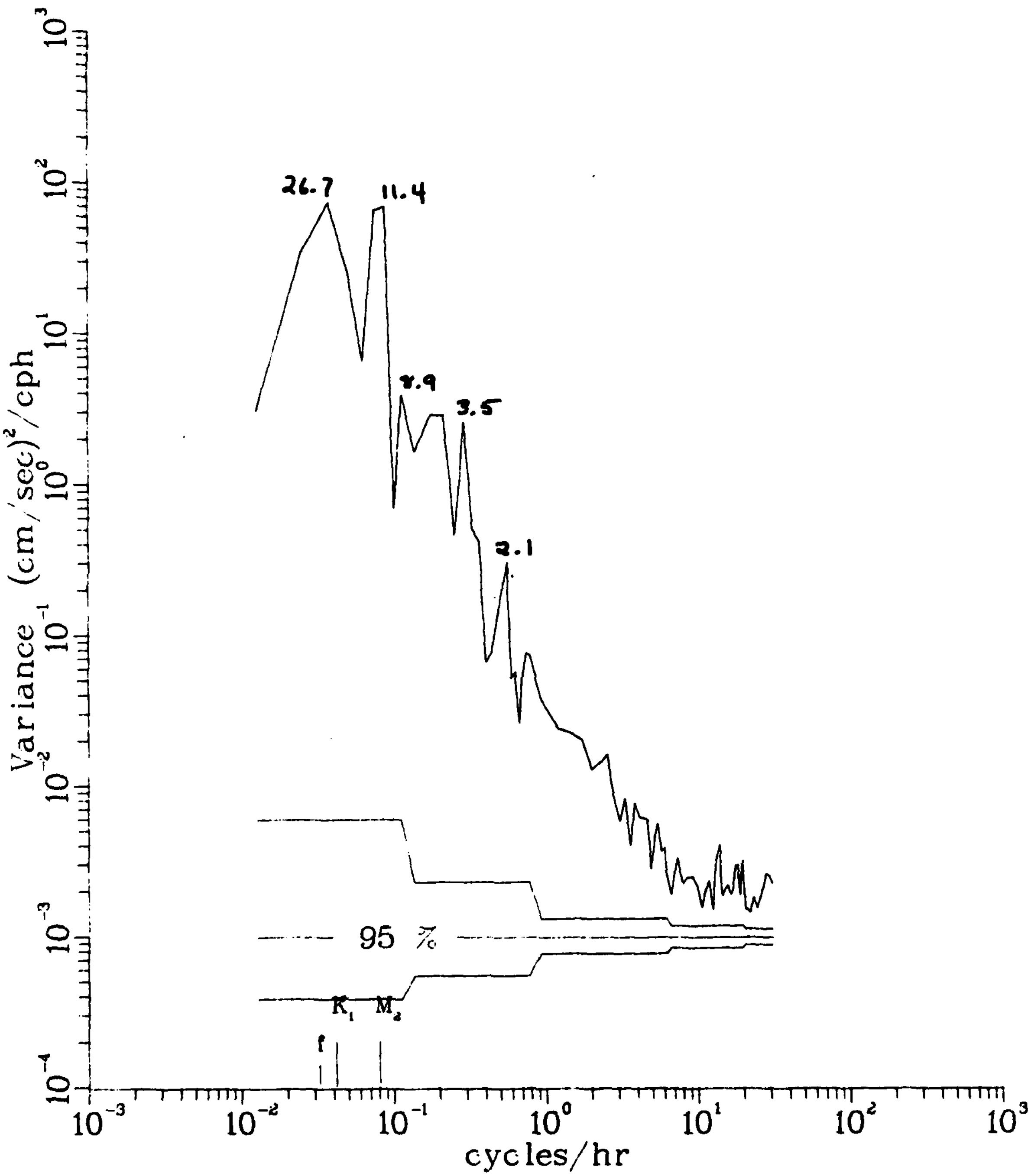
Figure 11. Meter 289 v(north) spectrum



Variable : U
Depth . 4478
Meter . 289
Lat. 22.46.350
Long. -46. 4.589

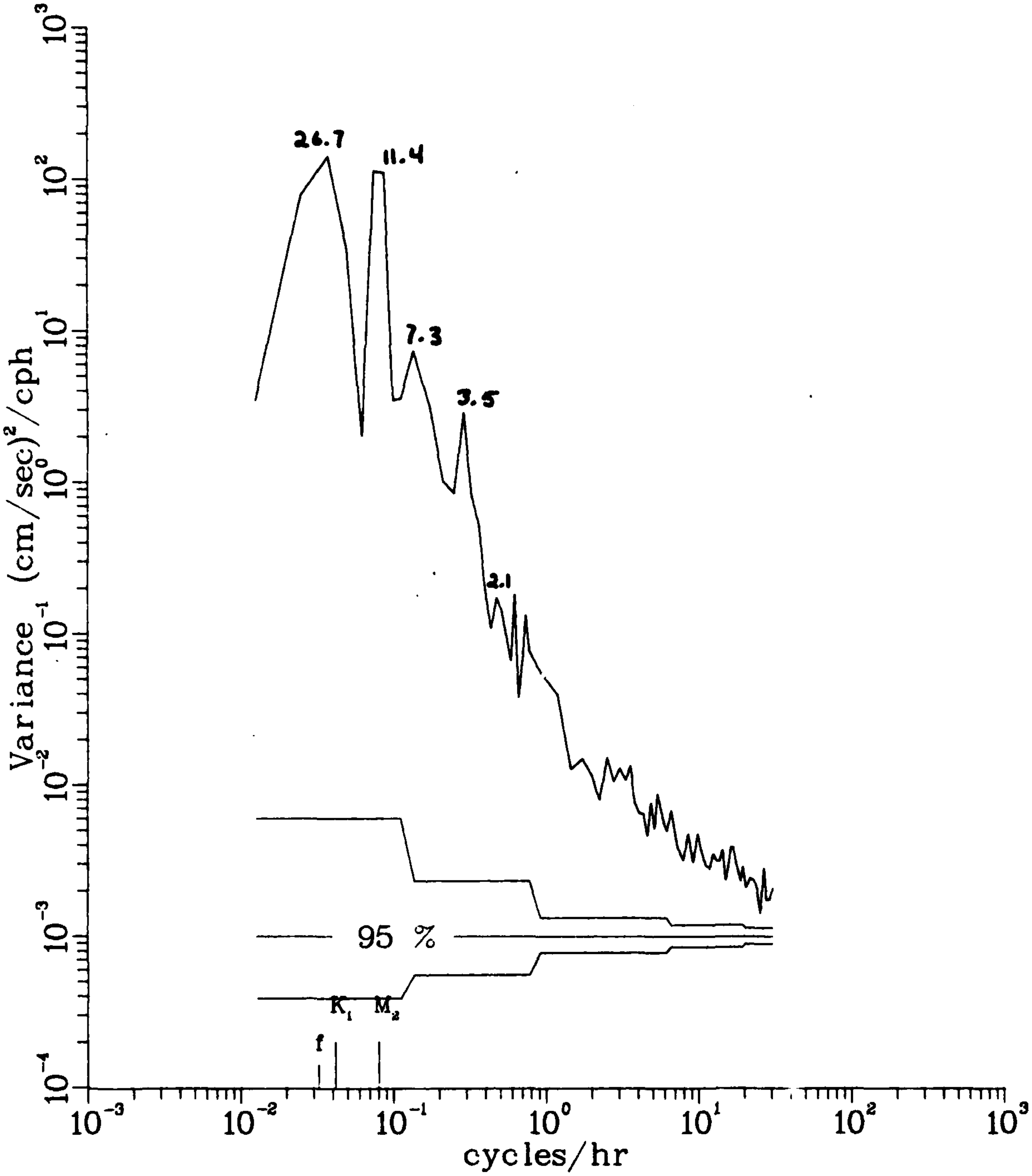
Variable . V
Depth . 4478
Meter . 289
Lat. 22.46.350
Long. -46. 4.589

Figure 12. Meter 289 rotary spectra



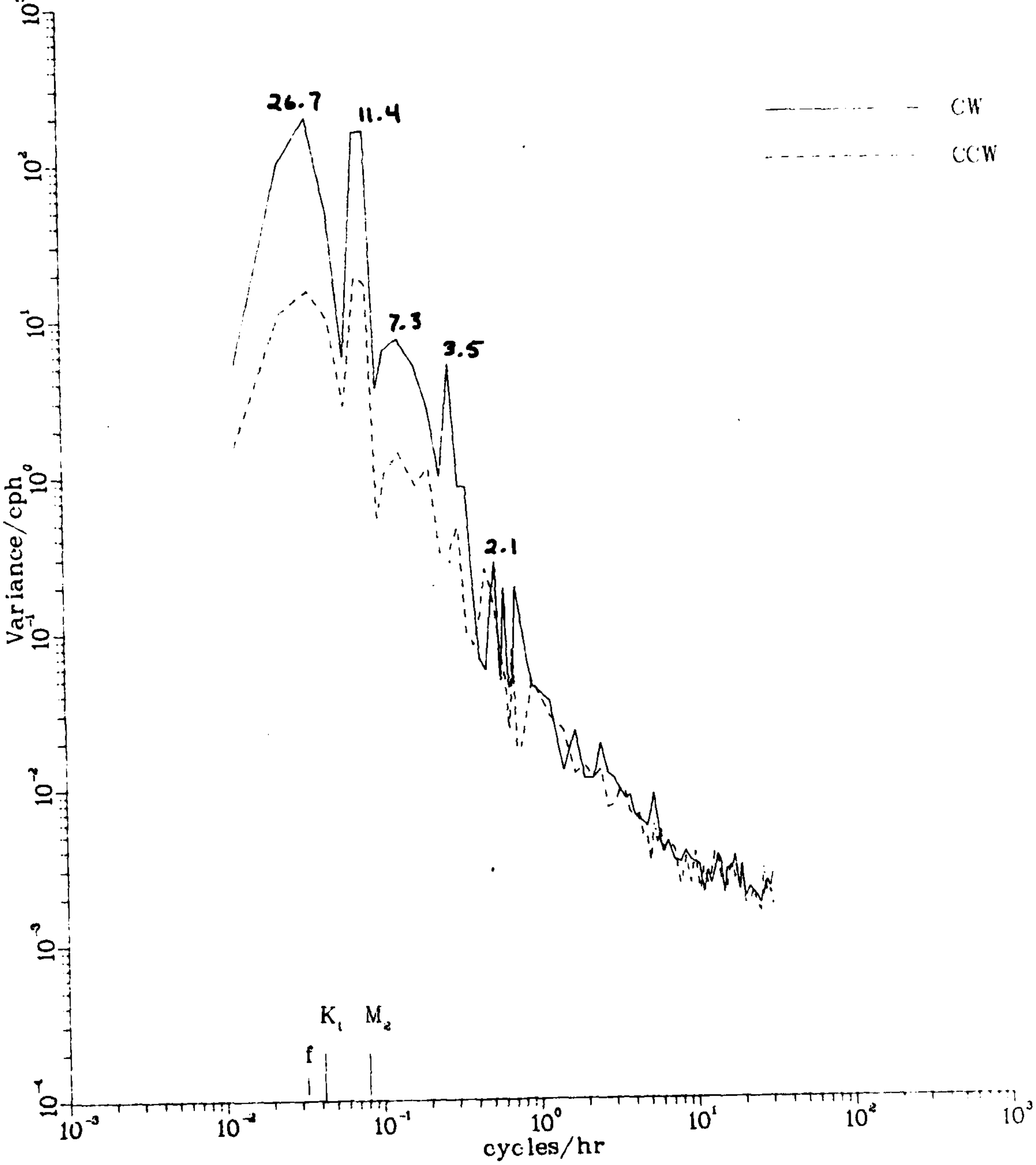
Variable :	U	Array	001001
File .	070581	Depth .	4478
Meter	300	Start .	28 MAR 1900
Lat.	22.46.102	End .	31 MAR 1900
Long.	-46. 5.493		

Figure 13. Meter 300 u(east) spectrum



Variable .	V	Array .	001001
File .	070581	Depth .	4478
Meter .	300	Start .	28 MAR 1900
Lat.	22.46.102	End .	31 MAR 1900
Long.	-46. 5.493		

Figure 14. Meter 300 v(north) spectrum



Variable . U		Variable . V	
Depth .	4478	Depth .	4478
Meter	300	Meter	300
Lat.	22.46.102	Lat.	22.46.102
Long	-46. 5.493	Long.	-46. 5.493

Figure 15. Meter 300 rotary spectra

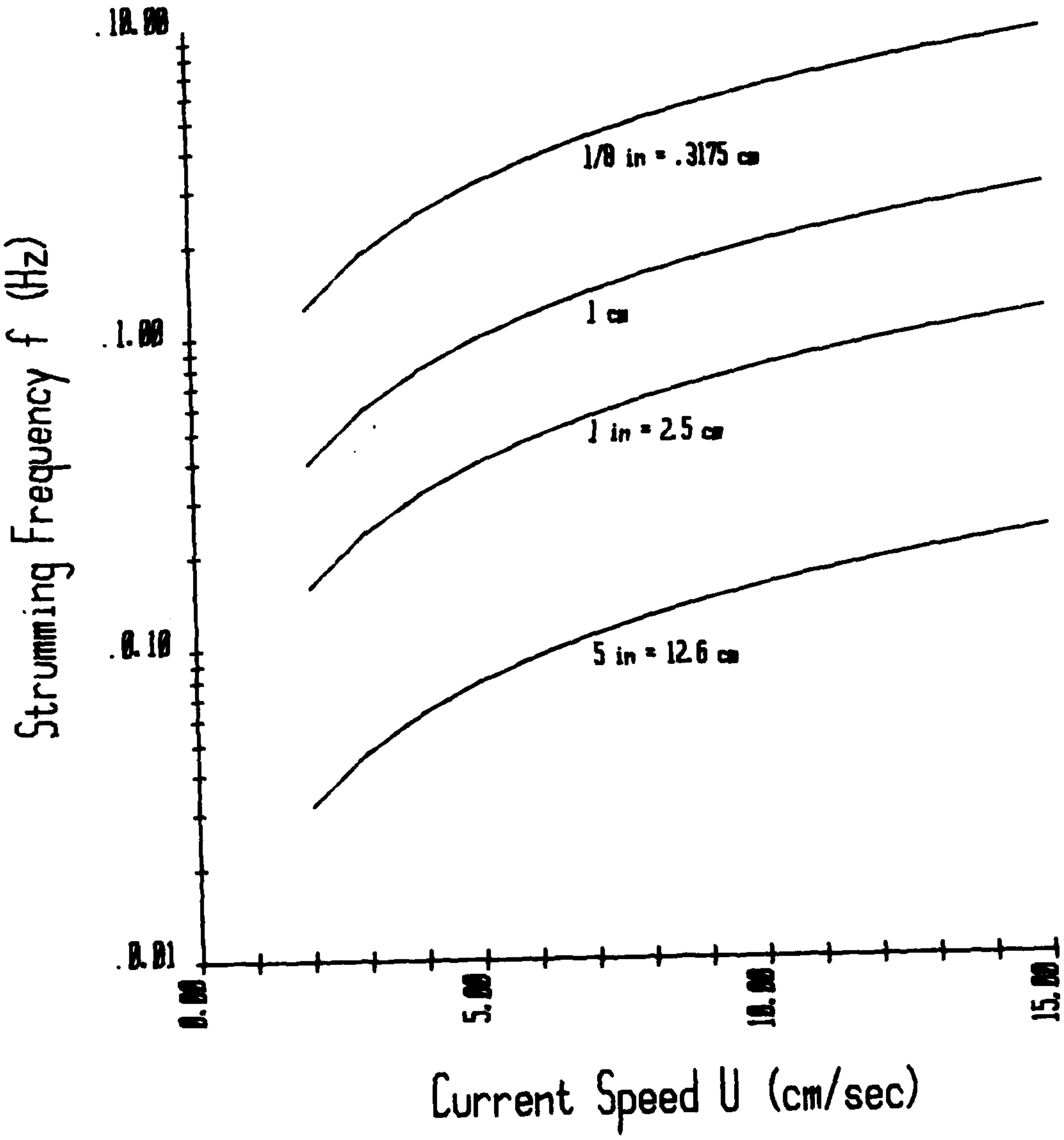


Figure 16. Strumming frequency versus current speed for cylindrical bodies of various diameters in flows of Reynolds number 2×10^2 - 4×10^5.

APPENDIX

Near-surface current profiles taken with the NBIS DRCM during deployment of MSS borehole instrumentation package.

DRCM LOG SHEET

CAST # 1 Date: 26 March '81 - 27 March 81

Intensive cast to be conducted prior to BIP launch

Start time: 2150Z (26) Latitude/Longitude: 22°45.35'N / 46°04.90'W

Completion time: 0151Z (27)

DEPTH (meters)		CURRENT SPEED (cm/sec)	CURRENT DIRECTION (°Magnetic)	COMMENTS
Nominal	Actual			
10	11	46	299	Considerable wire
20	21	49	294	angle
30	31	45	296	"
40	41	34	293	"
50	50	36	286	"
60	60	18	284	"
70	70	40	292	"
80	80	21	274	"
90	91	15	270	"
100	100	18	276	"
150	152	10	269	
200	200	5	249	
250	250	13	274	Swell at times
300	300	11	262	
350	349	7	219	
400	400	7	250	
500	500	10	284	
600	600	6	274	
700	700	11	320	
800	800	10	005	
900	900	6	363	
1000				

DRCM LOG SHEET

CAST # 2 Date: 27 March '81

Intensive cast to be conducted prior to BIP launch

Start time: 0331 Z   Latitude/Longitude: 22° 45.35'N / 46° 04.90'W

Completion time: 0643 Z

DEPTH (meters)		CURRENT SPEED (cm/sec)	CURRENT DIRECTION (°Magnetic)	COMMENTS
Nominal	Actual			
10	11	2	258	
20	20	6	313	
30	31	5	270	
40	42	3	263	
50	50	4	253	
60	62	5	266	
70	70	6	294	
80	81	7	292	
90	91	6	290	
100	101	7	296	
150	149	4	274	
200	199	4	264	
250	250	7	347	Wire moving in circular
300	300	5	350	fashion under ship motion
350	350	6	014	forcing.
400	399	16	090	Swell
500	500	17	073	"
600	604	18	087	"
700	697	6	044	
800	795	20	106	Ship's orientation changed
900	897	14	071	using bow thruster
1000	1000	16	062	

DRCM LOG SHEET

CAST # 3 date: 27 March '81

Verification cast to be taken while BIP is being lowered

Start time 0903 Z Latitude/Longitude 22°45.35'N / 46°04.90'W

Completion time 1143 Z

DEPTH (Meters)		CURRENT SPEED (cm/sec)	CURRENT DIRECTION (°Magnetic)	COMMENTS
NOMINAL	ACTUAL			
10	11	5	217	Swell
50	51	9	127	"
70	71	10	136	"
100	100	8	156	
150	150	4	146	
200	201	5	129	Ship orientation has changed 180° since beginning
250	252	4	042	
300	302	8	098	
350	349	6	075	
400	401	7	079	Wire moving in circular fashion
500	501	18	081	
600	600	14	087	
700	701	14	075	
800	798	17	104	
900	897	12	086	
1000	997	15	091	15° Wire angle

NOTES:

DRCM LOG SHEET

CAST # 4 date: 27 March '81

Verification cast to be taken while BIP is being lowered

Start time 1421Z Latitude/Longitude 22°45.35'N/46°04.90'W

Completion time 1652Z

DEPTH (Meters)		CURRENT SPEED (cm/sec)	CURRENT DIRECTION (°Magnetic)	COMMENTS
NOMINAL	ACTUAL			
10	11	9	283	
50	50	4	249	
70	72	7	274	
100	100	3	185	
150	150	3	065	
200	199	5	105	
250	248	14	132	
300	301	5	113	
350	351	5	084	
400	401	4	109	
500	500	3	048	
600	600	6	351	
700	702	10	032	
800	800	5	349	
900	900	7	015	
1000	1001	7	025	

NOTES: Occasional erratic readings past 200 m.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NORDA Technical Note 132	2. GOVT ACCESSION NO. AD-A114 135	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Ocean Current Effects on Marine Seismic Systems and Deployments		5. TYPE OF REPORT & PERIOD COVERED Final (FY81)
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Janice D. Boyd		8. CONTRACT OR GRANT NUMBER(s)
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11. CONTROLLING OFFICE NAME AND ADDRESS Same as above		12. REPORT DATE January 1982
		13. NUMBER OF PAGES 42
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Currents	Ship motion
Abyssal currents	Deep Sea Drilling Project
Mid Atlantic	Marine Seismic System
Vector averaging current meter	Ocean bottom seismometer
Direct-reading current meter	Marine seismic noise

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Upper level and near bottom current measurements were made near DSDP Hole 395A (22°45'N, 46°10'W) in March-April 1981 in support of the at-sea test of the Marine Seismic System Project. Four upper ocean current profiles were made during initial deployment of the borehole seismometer. Readings were noticeably contaminated by ship motion, but clearly indicated a variable yet generally slow current regime which posed minimal threat of cable entanglement. Current measurements made 5 m off bottom during seismometer testing showed marked spectral peaks at semidiurnal and inertial frequencies. Mean speed of

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4.4 cm/sec and maximum speed of 9 cm/sec were low but possibly of sufficient magnitude to cause contamination of concurrently deployed ocean bottom seismometer records with hydrodynamically generated noise. Other studies have confirmed noise contamination of OBS records by near bottom currents, with a possible 10 cm/sec threshold for its importance. While methods to detect and eliminate the noise might be developed, instrument testing and redesign to reduce sensitivity to contamination is probably wiser.

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